

The functional response of metamorphosis rates to climatic variation: A case study with *Amblyomma variegatum*

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Amblyomma variegatum is a three host hard tick that has demonstrated extensive range expansion over the last 150 years. This ‘Tropical Bont Tick’ vectors a number of economically important bacterial diseases of ruminants including the pathogen *Ehrlichia ruminantium*, causative agent of the highly virulent disease heartwater. Control of *A. variegatum* populations and its associated diseases would be easier if population dynamic models were capable of predicting tick densities across heterogeneous environments and in response to a number of candidate control measures.

Mechanistic population dynamic models describing the life cycle of the tick are known to be sensitive to both parameterisation and the choice of functional response linking demographic rates to environmental, and in particular climatic, variation. Prediction accuracy therefore depends fundamentally on the choice of functional response used within population dynamic models. We use field experiment data to compare the explicative power of competing hypotheses of functional response in a hybrid mechanistic-statistical modeling framework targeting the developmental and metamorphosis process undergone by engorged nymphs on passage to adult stage. Engorged nymphs were placed in cages at various altitudes in the mountains of Madagascar and the data used to parameterise a mechanistic model. The observed metamorphosis rate was modelled as a function of temperature data measured every 15 minutes at six sites using Tiny Tag climatic loggers. Various hypotheses linking metamorphosis rates to thermal accumulation are tested in a Bayesian framework.

Results indicate that important non-linear relationships are identifiable in a mechanistically rich Bayesian approach using experimental data obtained in natura. We discuss the importance of the identified functional responses and remaining uncertainties in the context of predictive population dynamic models. A number of key outstanding research questions targeting key transitions in the *A. variegatum* life cycle are presented.